



Abstract: Working with the IAG geometric services (VLBI, SLR, GNSS, and DORIS) the Bureau continues to advocate for the expansion and upgrade of the space geodesy networks for the maintenance and improvement of the reference frame and other application, and for the extension and integration with other techniques. New sites are being established following the GGOS concept of “core” and co-location sites; new technologies are being implemented to enhance performance in data yield as well as accuracy. In particular, several groups are undertaking initiatives and seeking partnerships to update existing sites and expand the networks in geographic areas void of coverage. The Bureau continues to meet with organizations to discuss possibilities of new and expanded participation and to promote the concept of partnerships. The Bureau provides the opportunity for representatives from the services to meet and share progress and plans, and to discuss issues of common interest. The Bureau monitors the status and projects the evolution of the network based on information from the current and expected future participants. Of particular interest at the moment is the integration of gravity and tide gauge networks. The Committees and Joint Working Groups play an essential role in the Bureau activity. The Standing Committee on Performance Simulations and Architectural Trade-off (PLATO) uses simulation and analysis techniques to project future network capability

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GGOS Bureau of Networks and Observations: Overview

Role of the Bureau: To advocate and encourage implementation of the Core and Co-location Network to satisfy GGOS requirements, to monitor the status of the network and project its future condition, and to support and advocate for infrastructure critical for the development of data products essential to GGOS.

Objectives: The current objective is the deployment of a globally distributed network of 32, new technology core sites with VLBI, SLR, GNSS and DORIS to achieve reference that will permit mm accuracy at 0.1 mm/year stability over decades. The new role of the Bureau is now being expanded to better integrate the non-geometric Services (Gravity Service, tide gauge networks, etc.) and to strengthen communications with the space missions, the simulation activities to project network capability, and some of the data gathering functions.

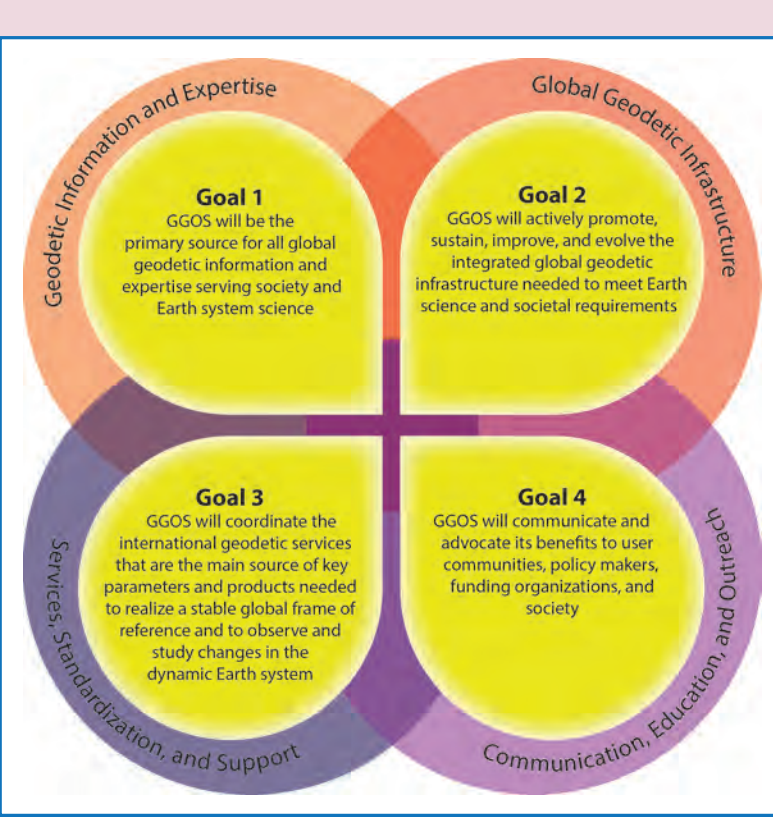
Reality: Site deployment and upgrade will occur over many years, and some sites for economic and political reasons will not be in the ideal locations. Co-location sites (non-core sites) will continue to play a vital role in our data products. The utility of our output will be the product of network Core Sites, Co-location sites, mix of technologies, adherence to proper operational and engineering procedures, and making best use of the data once it leaves the field.

Organizational Elements

- Services networks (IGS, IVS, ILRS, IDS, IGFS, tide gauges, etc.)
- Standing Committees: (Performance Simulations and Architectural Trade-Offs/PLATO. Data and Information Systems, Missions, IERS WG on Site Survey and Co-location)

GGOS Organization: Elements within Bureau are intended to work as an integrated team whose main focus is to ensure that the networks required to collect the data that will support the GGOS products are in place and produce these data.

Bureau Leadership: Board made up of a Director, Secretary, Analysis Coordinator, a representative from each Network Service and Working Group.



IAG Services: Recent Developments

International GNSS Service (IGS)

- IGS network now consists of 509 stations, 183 multi-GNSS, 198 real-time (<http://www.igs.org/network>)
- IGS Strategic Plan revised and in review, aided by community input through Strategic Planning Survey; currently in review by IGS Governing Board with expected publication on IGS website by May/June 2017
- IGS Analysis Coordination now performed by Geosciences Australia/MIT team using cloud-based server technology
- IGS products transitioned to IGS14 Reference Frame in January 2017
- Real-time casters (servers) operational at IGS Data Centers; IGS Central Bureau caster now hosted at UCAR supercomputer data center; IGS considering issues related to signal redistribution for commercial applications
- IGS Working Group to support GNSS Performance Monitoring WG and Trial Project formed; currently defining monitoring parameters, initiating trial project
- 2016 IGS Technical Report published April 2017
- 2016 IGS Workshop held in Sydney Australia in February 2016; proceedings and presentations/videos available through IGS website (<http://www.igs.org>)
- 2017 IGS Workshop to be held in Paris France hosted by IGN, CNES, and Campus Spatial of the University of Paris-Diderot in July 03-07, 2017 (<http://igsworkshop2017.ign.fr>)
- Multi GNSS Experiment (MGEX) achievements article published in Advances in Space Research by Montenbruck, et al.

International VLBI Service for Geodesy and Astrometry (IVS)

- Based on discussions at the IVS 2015 Retreat a strategic plan for the next decade was developed and published
 - A proceedings volume of the 9th IVS General Meeting was prepared and published; the volume encompasses 77 papers on about 400 pages; an online version is available on the IVS website (<https://ivscg.gsfc.nasa.gov>)
 - Progress was made in achieving operational readiness of the next generation VLBI system, the VLBI Global Observing System (VGOS). Broadband fringes were found on transatlantic and transpacific baselines. A first VGOS trial campaign of a network of 5–6 stations was observed (Trial #1). Due to antenna and backend issues the trial was not successful in terms of end-to-end testing of the full processing chain. However, valuable experience was gained in improving and streamlining operational procedures at the stations. The trial campaign will be repeated in 2017.
 - New VGOS antennas are under construction at Ny-Ålesund (Norway), Onsala (Sweden), Hartebeesthoek (South Africa), Metsähovi (Finland), and Shanghai (China). The Australian AuScope antennas at Hobart, Katherine, and Yarragadee will be upgraded to a VGOS broadband system in the second half of 2017.
 - The IVS contributed to the determination of the alignment of the future Gaia optical frame to the current radio frame (ICRF2) by observing ICRF2-Gaia transfer sources. Details are described in <http://dx.doi.org/10.3847/0004-6256/151/3/79>.

International Laser Ranging Service (ILRS)

- ILRS tracks over 90 targets including LEO, HEO, GNSS, GEO, and lunar arrays; several targets require restricted tracking to avoid optical damage
- New stations established or in process by Russian Federation, NASA, BKG, ISRO, China, Finland, Norway, etc.; spatial gaps still exist in Africa, Central America, Oceania, etc; some remote stations being outfitted with a second SLR system to relieve the tracking load
- The ASC has implemented the new ITRF2014 in its operational products; the Systematic Error Monitoring PP is coming to closure and it will soon evolve into an operational tool; the next PP will seek to introduce LARES as a fifth target and low-degree gravitational harmonics as a new ILRS product
- Data Quality Board monthly telecons held to address laser ranging data quality issues
- The updated ILRS TOR includes two new at-large members to the Governing Board
- 20th International Workshop on Laser Ranging held at GFZ in October 2016 (<https://cddis.nasa.gov/lw20/>)
- 2017 ILRS Technical Workshop to be held in Riga, Latvia in October 2017 (https://ilrs.gsfc.nasa.gov/docs/2017/2017ILRS_TechnicalWorkshop_circular1_20170228.pdf)
- Call for papers for Journal of Geodesy Special Issue on Laser Ranging completed; selection underway

International DORIS Service (IDS)

- With the recent addition of DORIS, Wettzell is now a new four techniques co-location site
- Based on reconnaissance and RF compatibility tests, the Papenoo (French Polynesia) site is compatible with GGOS requirements and would represent a major French contribution to GGOS
- Based on a detailed design review, the prototype 4th generation DORIS beacon is ready for manufacturing
- Complementing the work done about “DORIS Starec ground antenna characterization and impact on positioning” (Tourain et al., 2016), an RF characterization of the Alcatel antenna (previous DORIS antenna type 1986-2007) has been recently performed
- Franck Lemoine (NASA/GSFC) succeeds Pascal Willis (IGN) as Analysis centers representative and IDS chairperson
- DORIS special issue in Advances in Space Research (co-edited by: Frank G. Lemoine and Ernst J.O. Schrama) published December 2016
- New Working Group formed on NRT DORIS data (chair: D. Dettmering) to examine the relevance of such products
- Two new DORIS data products are now available: DPOD (DORIS extension of the ITRF for Precise Orbit Determination), and long-term DORIS position and velocity cumulative solution

Permanent Service for Mean Sea Level (PSMSL)

- Links have been established between Revised Local Reference (RLR) data series and geocentric heights; PSMSL now offers information about geocentric height and vertical rate of movement of some tide gauges; estimates dependent on linking tide gauge's primary benchmark with GNSS receiver through leveling
- Changes to MSL Time Series with some Mean Tide Level (MTL) values; primarily effects in older (early 1900s) time series (note that changes to data flags were required)
- Developing a more structured and standardized approach to descriptive metadata
- Updated Trend and Anomaly Maps to account for MTL -> MSL changes noted above;



GGOS Bureau and Standing Committees: Recent Updates and Future Tasks

GGOS Bureau of Networks and Observations:

- Advocate for implementation of global space geodesy network of sufficient capability to achieve data products essential for GGOS;
- Report on status, plans, and issues for the Bureau entities at Bureau and public meetings; keep an updated Bureau section of the GGOS website for public use;
- Continue to oversee the Bureau's “Call for Participation in the Global Geodetic Core Network: Foundation for Monitoring the Earth System” and work with new potential groups interested in participating;
- Meet with interested parties and encourage partnerships
- Provide a venue for the IAG services and standing committee/working groups to meet, share status and plans, and examine common interests and requirements
 - Organize meeting at EGU, AGU, and other opportunities
- Maintain the “Site Requirements for GGOS Core Sites” document (with the IAG services) (June 30, 2017)
- Monitor and project the status and evolution of the GGOS space geodesy network in terms of location and performance (with the IAG services)
 - Issue next questionnaire and compile responses (August 31, 2017)
- Facilitate efforts to integrate relevant parameters from other ground networks (gravity field, tide gauges, etc.) into the GGOS network to support GGOS requirements; advocate for installation of GNSS receivers at appropriate tide gauges

Standing Committee on Performance Simulations and Architectural TradeOffs (PLATO) (Daniela Thaller/Richard Gross):

- Examine trade-off options for station deployment and closure, technology upgrades, impact of site ties, etc. (August 31, 2017)
- Simulation studies “ground” to assess impact on reference frame products of: network configuration, system performance, technique and technology mix, co-location conditions, site ties (December 31, 2017)
- Simulation studies “space” to assess impact on reference frame products of: co-location in space, space ties, available satellites (December 31, 2017)
- Project future network capability over the next 5 and 10 year periods using projected network configuration in new system implementation; (February 28, 2018)
- Develop improved analysis methods for reference frame products by including all existing data and available co-locations (June 30, 2018)
- Analysis campaign with exchanged simulated observations (December 31, 2018)
- Status reports at IAG Scientific Assembly (July 2017), GGOS days (October 2017) and REFAG Meeting (Fall 2018)

Standing Committee on Data and Information Systems (Gunter Stangl/Carey Noll):

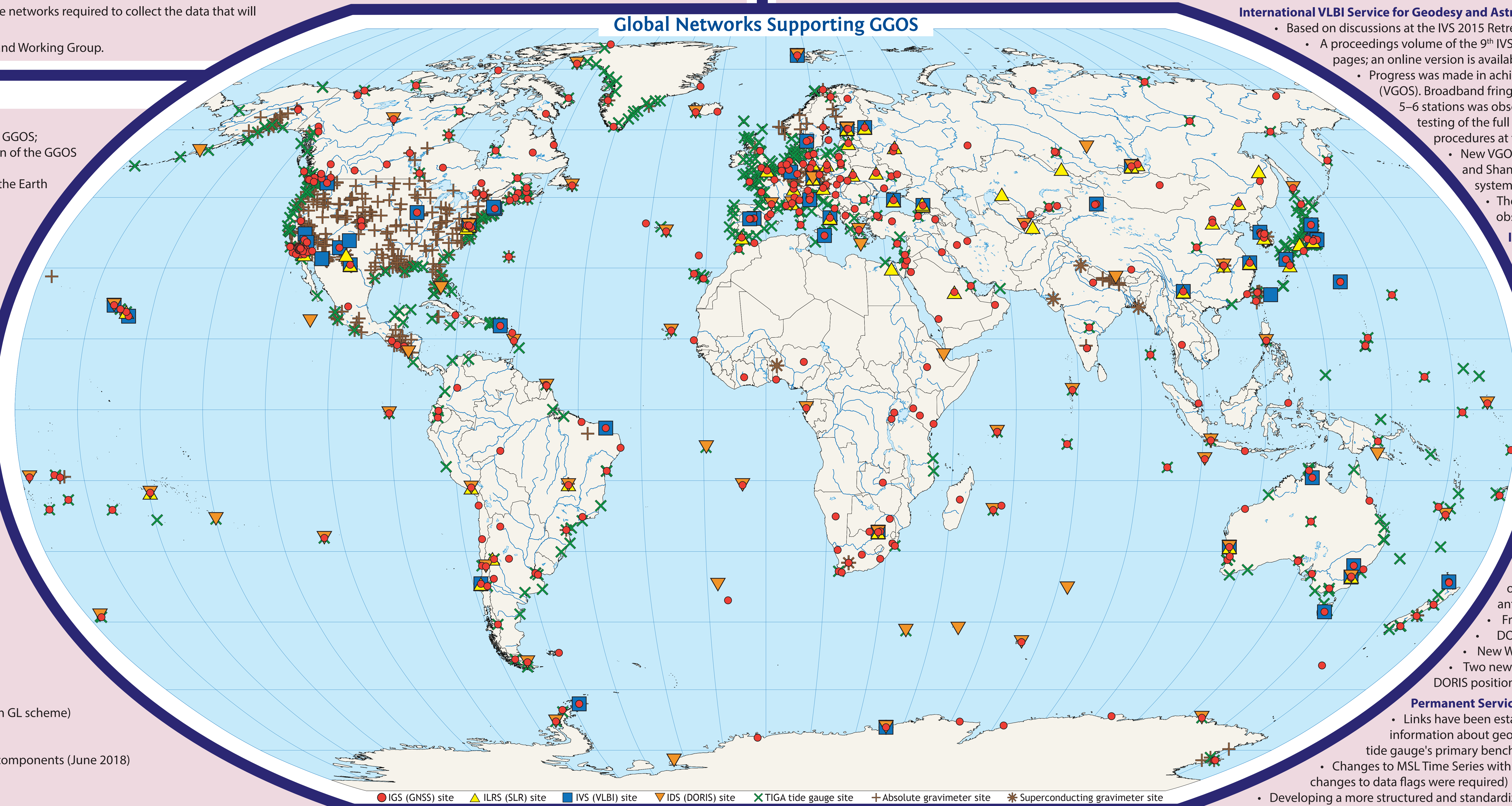
- Adopt and implement a metadata system to provide access to GGOS relevant data products (December 30, 2017)
 - Define the data product requirements for the GGOS relevant metadata (February 15, 2017)
 - Present concept and plan for implementation (EGU 2017 and/or the GGOS CB meeting in April 2017)
 - Status report (IAG Assembly or other venue in July 2017)
 - Prototype of Phase 1 implementation (GGOS Days in October 2017)
 - Implementation of the operational data product metadata scheme (December 31, 2017)
- Adopt and implement a full metadata system including site information and relevant tools and capability (e.g., the Australian GL scheme)
 - Definition of the requirements; definition of Phase 1 (March 1, 2018)
 - Resolve issues and applicability of the Australian GL scheme and recommend schema (EGU 2018)
 - Metadata implementation plan including definition of tasks, roles, and distribution of tasks, and plans for integration of components (June 2018)
 - Demonstration of Phase 1 prototype (GGOS Days, 2018)
 - Demonstration of Phase 1 first operational system (June 2019)

Standing Committee on Missions (Juergen Mueller/Roland Pail):

- Agree in the content and develop a CSM section on the GGOS website for public access; implement a procedure to keep the section up-to-date (first version should be ready Spring 2017)
- Revise the inventory/repository of current and near-future satellite missions (a reduced list should be available by mid-2017)
- Evaluate the contribution of current and near-future missions to GGOS 2020 goals (first update early 2017)
- Support and advocate for new missions; new calls expected in 2017/2018 that shall be supported
- Expand the role of the Standing Committee beyond gravity field satellites (e.g., altimetry, geodetic satellites, etc.) working with the PLATO Committee (end of 2017)

IERS Working Group on Site Survey and Co-location Tasks (Sten Bergstrand):

- Develop a guidelines document of standard nomenclature (June 30, 2017)
- Support IGN in the development of a readily accessible archive containing the results from all of the site ties and eccentricities (current and historical)
- Develop a plan for an outreach approach to station managers at co-location sites to stress the need for accurate local ties and the need for seeking local survey capability; stress outreach to surveying teams in China, Russia, and Japan in order to establish common guidelines (AGU 2017)
- Work with the Services to document procedures to determine system reference points and evaluate their accuracies (first discussion Bureau meeting in EGU 2017)



trends now give a better measure of uncertainty, indicating the period of time needed to reach uncertainties of 1.0, 0.5 and 0.1 mm/yr

International Gravity Field Service (IGFS)

- Promoting the establishment of the Global Geodetic Reference System/Frame (GGRS/GGRF) and the International Height Reference System/Frame (IHRF/IHRF)
- Implementing new IGFS webpage at the IGFS CB
- Defining new metadata standards for absolute and relative gravity data
- Participating to the establishment of the new absolute gravity reference system/frame

